Notes on Dipterocarps.

No. 7. On the fruit and germination of *Isoptera borneensis.*

By I. H. Burkill.

Isoptera borneensis, Scheff., is a tree which yields much of the Tangkawang fat produced in Malaya. Borneo, where its extension is through the island, is the centre of its distribution: eastwards it reaches Mindanao and westwards the Malay Peninsula, Bangka and south Sumatra. It is a large, but apparently not a very large tree. Its habitat is the margins of rivers of moderate size. Into their waters it drops is fruits, and they are distributed by them.

The following is a figure of the fruit in the position in which it floats, the buoyant sepals upwards.

Fig. 1. A seed of *Isoptera borneensis,* in the position in which it floats. ½ nat. size.

Deprived of the corky sepals, the fruits within 60 hours, sink however dry at the starting of the experiment.

In Note no. 4 of this series (Journ. Straits branch Roy. As. Soc. no. 81, 1920, p. 75) an account was given of the floating fruit of *Vatica Wallichii,* Dyer (Pachynocarpus Wallichii, *King*) wherein the buoyant tissue is the fruit-wall, i.e. the same end is attained but by different means.

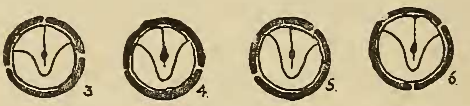
It is not possible to regard water-distribution as in any way ancestral in the order; but it appears in *Vatica* as an ultimate modification at the end of a series which has lost the advantage of height and thereby lost the wind that does not reach a small tree deep in high forest: and it would seem to be connected with fruiting before the tree is of any great height in *Isoptera borneensis;* for the tree commences to fruit at the early age of six years (fide van Romburgh and Ridley). But though *Vatica Wallichii* and *Isoptera borneensis* use water as a means for the distributing of their seeds they have little else in common, being wide apart in their order.

The embryo of *Isoptera borneensis* is very like that of some Shoreas, say of *S. costata,* in being grooved down the sides and in end-view, as figured here; but both its cotyledons reach the apex of the fruit-cavity, though the outer is so much the larger that it possesses anything from 240 to 280 degrees of the circumference at the equator of the seed.

Fig. 2. Embryo of *Isoptera borneensis* seen from the end showing the outer cotyledon folded over the placentar cotyledon. ½ nat. size.

The vitality of the seed is not great. The fruit floats and germinates floating if the purpose of floating has not been achieved by a stranding in some new spot. Probably the end of germinated floating fruits arrives very quickly and the seedling perishes: it is heavier than water, and falling from the fruit sinks.

In germination the fruit-wall ruptures at no constant place, but in response to the pressure of the variable young plant within and not at any weak lines in the wall. Here are four diagrams



Figs. 3—6. Diagrams of the position of the cracking of the fruit-wall in the germination of the seed of *Isoptera borneensis*. No. 3 is the most usual way. No. 4 is not uncommon being No. 3 as it were incomplete; No. 5 is No. 4 oblique,; No. 6 is the reverse of No. 3.

showing the cotyledons in transverse section: the outer cotyledon in germination has a tendency to flatten itself, which tendency pushes chiefly right and left, and is fortified by a similar tendency in the inner or placentar cotyledon; this results further in a second direction of pressure,—towards the part of the wall where the placenta is, i.e. upwards in the diagrams. Under these pressures the wall gives way, first as a rule on the right and on the left, and either later near the placenta, or (diagram 4) not at all. The commonest form of splitting is that in diagram 3, the third, last and often not extensive, crack being close against one side of the attachment of the placenta to the wall.

In diagram 5 is a case where the lobes of the placentar cotyledon were unequal and the splitting unusually oblique.

If the fruit is split into two, as in diagram 4, the two parts are nearly halves. Here are approximate measurement in degrees of a circle of six fruits split into two:—

173°
187° placenta attached about the middle of the smaller part.

180°
180° placenta attached about the middle of one of the parts.

189°
171° placenta attached about the middle of the larger part.

201° / 159°	placenta attached about the middle of the larger part.
187° / 173°	do.
180° / 180°	placenta attached at 45° from the centre of one half.

When the fruit wall is split into three parts after the manner of diagram 3, ascertained measurements were

120° ⅄ 136°	124° ⅄ 112°	125° ⅄ 110°
84°	124°	125°
138° ⅄ 84°	162° ⅄ 93°	131° ⅄ 120°
138°	105°	109°

It is easy to understand what happens in these seeds from these few measurements. Take the diagrams, which have purposely been oriented for the sake of this explanation; the pressure of the embryo is greater transversely than in any other direction and results in the giving way of the fruit-wall at either side: if the giving way occurs at points more or less diametrically opposite, the pressure needs no further cracking: but if the first cracks appear rather to the lower side of the diagrams, then the embryo continuing to grow produces a new crack more or less mid way upon the larger part, that is generally in the neighbourhood of the attachment of the placenta. If as in diagram 6 the crack is too much to the upper side then a third crack must appear upon the lower or larger part to allow of the germination proceeding. I measured only two fruits of this type and I found them:—

106	97
127 Y 127	146 Y 117

This method of fruit-splitting, easy to demonstrate in *Isotoma borneensis,* is characteristic of the greater part of the order. It is not dehiscence, for the product of fertilisation in the order never ceases growing from the moment of fertilisation to the time when the produced plant dies: the embryo grows into the seed and devours its albumen, which done it is normally cast from the parent tree, not quiescent as so many seeds are, but still growing, and in the course of its growth it ruptures the fruit-wall as described. Under abnormal conditions it may not be cast from the parent tree, and then germinates suspended (van Romburgh).

If only we knew the workings of the process by which the tree cuts off nutriment from its offspring, we should know the strength of the barrier preventing vivipary from being anything but a phenomenon exhibited by few and peculiar Phanerogams.

As far as is known, it is universal for the Dipterocarps to possess in the ovary three chambers and six ovules, two in each: one ovule only in all normal cases matures. One flower only, shall we say, in 10,000 matures fruit. It is remarkable then, that the production of the six ovules to each flower should be so constant, and it suggests an ancestry which had not winged fruits as so many modern Dipterocarps have, because six seeds carried away together on the wind would be too heavy a load for efficient wind-distribution and, settled together, would compete unprofitably. Wind-distribution appears, therefore, a less ancient phenomenon than their six ovules, but yet it is so general as to be characteristic of the order. It is easiest to consider it as co-aeval in the order with its separation from something more ancient, and to consider the absence of it to be subsequent or secondary. *Isotoma* has lost it,—has taken to water-distribution as an alternative. *Vatica Wallichii* has done the same. Some species of *Shorea* such as *S. Thiseltoni*, some of *Dryobalanops*, some of *Vatica*, the species of *Balanocarpus*, and the species of *Pachynocarpus* hold their own producing fruits very heavy for wind to lift them, and are distributed through small distances by being rolled or carried along the floor of the forest. They too have lost their wings. If we think of the evolution of the order as suggested it is of the greatest importance to understand that the splitting of the fruit-wall is not along definite lines, that is to say there is in it no sign of a pre-Dipterocarp dehiscent condition when six seeds might mature and need for the sake of efficiency that they be scattered singly.

Against this line of argument it has to be admitted that some species of the genus *Vatica* possess weak lines in the walls of their fruits where rupture occurs. The lines seem tertiary however, and are being studied.

The cotyledons of *Isotoma borneensis* contain chlorophyll in abundance before germination, and on germination are exposed to to the light and held, like the cotyledons of most species of *Shorea*, upon short petioles.